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Patient Conditions and Associated ICD-9 Diagnosis Codes

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PROBLEM

Need to be able to validate medical models using DoD Deployable Medical System (DEPMEDS) Patient Conditions (PCs) with real world data documented with International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) codes

OBJECTIVE

- Evaluate quality of mapping between these two medical classification systems
  - Real World/Existing Medical Data: International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis codes
  - Medical Modeling and Simulations: DoD Deployable Medical System (DEPMEDS) patient condition (PC) codes

PATIENT CONDITIONS (PCs)

- Each PC represents a group of patients with similar medical conditions, therefore, similar treatment requirements
- Total of 389 PCs (codes numbered 1 - 440)
  - 318 PCs for conventional warfare (codes 1-350)
    - 96 for disease
    - 146 for non-battle injury (NBI)
    - 187 for wounded in action (WIA)
  - 75 PCs for nuclear, biological, and chemical warfare (codes 351-440)

PROBLEMS WITH PCs

- PCs
  - Do not identify specific clinical diagnoses or procedures
- Associated Treatment Brief
  - General in nature
  - Data based on subject matter expert opinion
- Associated frequencies, treatment time, hospital length of stay, and OR time
  - Based on subject matter expert opinion
  - Not directly derived from live data, such as SADR/SIDR with ICD-9-CM diagnosis and procedure codes

MODELS AND SIMULATIONS

- Models and simulations are increasingly important to DoD medical community
  - Requirement estimation for casualty care
  - Patient care
  - Integration of medical into line models and simulations
- Planning factors used in requirements estimation models and simulations based on SME data associated with DEPMEDS PCs
  - Treatment time (below level III)
  - Length of stay (by bed type, level III and above)
  - OR time
  - Probability of RTD, Death, Evacuation

PC TO ICD9 PROJECT DESCRIPTION

- Goal: Determine if mapping between coding systems possible, so medical model results can be validated with real world data
- Data from Army Graduate Management project
  - Three Certified Coders given PC Treatment Briefs
  - Each coder independently assigned all applicable ICD-9-CM diagnosis codes to each PC
  - *Each coder identified "key" diagnosis codes*
  - Initial set - 40 PC codes
  - Final set - 389 PC codes (*including initial 40*)
- Evaluate reliability/consistency of coding

RATER RELIABILITY

- Interrater reliability measures agreement, or consistency, in judgments by two or more individuals assessing same information

- Intrarater reliability measures consistency in judgment by an individual assessing same information multiple times

RATER RELIABILITY

- Methods of measuring rater reliability when outcomes are nominal
  - Percent agreement: Ratio of # times 2 raters agree/total ratings performed (0-100%)
  - Cohen's kappa statistic: Chance-corrected proportion of agreement (Cohen, 1960)
    - + kappa ➔ Agreement better than chance (max=+1.00 and occurs if total agreement)
    - 0.0 ➔ Agreement at chance level
    - – kappa ➔ Agreement worst than chance (min=-1.00)

KAPPA STATISTIC

$$k = \frac{\#\text{ exact agreements} - \Sigma\text{ freq agreements expected by chance}}{\#\text{ possible agreements} - \Sigma\text{ freq agreements expected by chance}}$$

Example

		Coder 1							
		864	884	894	959	Missing			∑chance
Coder 2	864	1					1		0.25
	884						0	Chance Agreements>	0.00
	894			1			1		0.25
	959					1	1		0.00
	Missing		1				1	Possible	0.25
		1	1	1	0	1	4	<Agreements	0.75
						Exact Agreements>		2	

$$k = \frac{2 - 0.75}{4 - 0.75} = \frac{1.25}{3.25} = \mathbf{0.3846}$$

CHALLENGES IN PERFORMING ANALYSES

- Mapping complexity
  - Most nominal outcome rating schemes:
    - Rater chooses single response per observation
    - 10 or fewer response categories available
  - PCs mapped to standard diagnoses:
    - Rater can choose several responses (diagnosis codes) per observation (PC)
    - More than 10,000 response categories available
  - Literature searches found no rater agreement analyses where raters could choose multiple responses from very large number of categories

CHALLENGES IN PERFORMING ANALYSES

- Study design
  - Multiple ICD-9-CM diagnosis codes selected for each PC
  - Coders provided minimal instruction
  - Data not checked for consistency or completeness at time of collection
- kappa calculation by SAS®
  - SAS computes kappa statistic from frequency tables
  - Tables must be square (both raters used same categories)
  - One rater's responses form rows, another rater's responses form columns

SOLUTIONS

- Simplified mapping complexity
  - Built data sets with consistent record layouts and formats
  - Converted 5-character ICD-9-CM diagnosis codes to 3-character codes (ICD9 codes)
- Performed pairwise analysis of 3 coders
  - Determined correct table structure
  - Created square tables with real and pseudo data
  - kappa calculation by SAS

SOLUTIONS

- Obtained reliability measures from 3 viewpoints

  1) Mappings of individual PC codes (amount of agreement in assigning ICD9 codes to a PC code)

  2) Identical mappings of individual PC codes (agreement is defined as assigning same set of ICD9 codes to a PC code)

  3) Mappings without regard to individual PC codes (what proportion of time did coders map to same ICD9 code across all PC codes)

EXAMPLE OF REAL & PSEUDO DATA RECORDS WITH ASSIGNED WEIGHTS

	PC	CoderA	CoderB	CoderC	Wt
Real	0001	x	800	800	1
	0001	x	801	801	1
	0001	x	802	x	1
	0001	803	803	803	1
	0001	x	804	804	1
	0001	850	850	x	1
Pseudo	0001	800	800	800	1E-10
	0001	801	801	801	1E-10
	0001	802	802	802	1E-10
	0001	803	803	803	1E-10
	0001	804	804	804	1E-10
	0001	850	850	850	1E-10
	0001	x	x	x	1E-10

EXAMPLE

The SAS System

----------PC=0001----------

The FREQ Procedure

Table of CoderA by CoderB

CoderA / CoderB	x	800	801	802	803	804	850	Total
Frequency								
x	1E-10	1	1	1	0	1	0	4
800	0	1E-10	0	0	0	0	0	1E-10
801	0	0	1E-10	0	0	0	0	1E-10
802	0	0	0	1E-10	0	0	0	1E-10
803	0	0	0	0	1	0	0	1
804	0	0	0	0	0	1E-10	0	1E-10
850	0	0	0	0	0	0	1	1
Total	1E-10	1	1	1	1	1	1	6

EXAMPLE

Statistics for Table of CoderA by CoderB
Test for Symmetry

Statistic (S)	4.0000
DF	21
Pr > S	1.0000

Kappa Statistics

Statistic	Value	ASE	95% Confidence Limits	
Simple Kappa	0.2941	0.1558	-0.0113	0.5995

Sample Size = 6.0000000007

Percent agreement = #agreements/#ICD9 codes compared * 100%

= (2/6) * 100% = 33.3%

RESULTS

- Summary results are presented for each viewpoint
  - By coder pair (AB, AC, BC)
  - Overall average
- Outcome measures
  - Mean number of agreements
  - Mean number of comparisons (e.g., average number of ICD9 codes each coder assigned)
  - Mean percent agreement (mean of given variable; not based on ratio of mean number of agreements to mean number of comparisons)

RESULTS

- Kappa statistic
  - Mean (mean of given variable; not based on chance corrected ratio of mean # agreements to mean # comparisons)
  - SD (standard deviation on mean kappa)
  - Mode (most frequently occurring kappa value)
  - Q1 (1st quartile or 25th percentile—value at or below which lie lowest 25% of given set of kappas)
  - Median (2nd quartile or 50th percentile)
  - Q3 (3rd quartile or 75th percentile)
  - 95% confidence intervals on mean kappa

RESULTS

- Kappa statistic
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  - Q3 (3rd quartile or 75th percentile)
  - 95% confidence intervals on mean kappa

INTERRATER AGREEMENT OF 3 CODERS IN MAPPING 389 PC CODES: Viewpoint I Mappings of Individual PC Codes

Coders	Mean # Agreements	Mean # ICD9 Codes Compared	Mean % Agreement	Kappa Statistic					
				Mean	SD	Mode	Q1	Median	Q3
AB	1.6	3.2	68.7	0.63	0.40	1.00	0.33	0.69	1.00
AC	1.5	3.0	67.5	0.60	0.43	1.00	0.31	0.69	1.00
BC	1.4	2.9	65.6	0.59	0.42	1.00	0.26	0.57	1.00
Overall	1.5	3.0	67.3	0.61	0.42	1.00	0.31	0.60	1.00

INTERRATER AGREEMENT OF 3 CODERS MAPPING 389 PC CODES: VIEWPOINT II Identical Mappings of Individual PC Codes

Coders	# of Perfect Agreements	% Agreement	Kappa Statistic		
			Kappa	95% Confidence Interval	
AB	188.0	48.5	0.48	0.43	0.53
AC	180.0	46.6	0.47	0.42	0.52
BC	177.0	45.9	0.46	0.41	0.51
Mean	181.7	47.0	0.47		

INTERRATER AGREEMENT OF 3 CODERS MAPPING 389 PC CODES: VIEWPOINT III Mappings Without Regard to Individual PCs

Coders	# of Agreements	# of ICD9s Compared	% Agreement	Kappa Statistic		
				Kappa	95% Confidence Interval	
AB	602.0	1224.0	49.2	0.45	0.42	0.49
AC	550.0	1125.0	48.8	0.46	0.42	0.49
BC	502.0	1104.0	45.5	0.41	0.37	0.45
Mean	551.3	1151.0	47.8	0.44		

RESULTS FOR 5 PC CODES ACCOUNTING FOR 25% OF SIMULATED WIA CASUALTIES

PC Code	WIA %	Mean % Agreement*	Kappa Statistic* Mean	Min	Max
131 Wound Lower Leg Open Lacerated Penetrating Perforating With Fracture And Nerve And/Or Vascular Injury Limb Salvageable	7.29	70.0	0.64	0.52	0.69
124 Wound Thigh Open Lacerated Penetrating Perforating With Fracture And Nerve And/Or Vascular Injury Limb	5.30	100.0	1.00	1.00	1.00
186 Multiple Non-perforating Fragment Wounds Of Skin And Soft Tissue	4.00	55.6	0.50	0.25	1.00
048 Wound Upper Arm Open With Fractures And Nerve Injury No Vascular Injury Arm	3.98	77.8	0.71	0.57	1.00
129 Wound Lower Leg Open Lacerated Penetrating Perforating Without Fractures Not Requiring Major Debridement	3.84	100.0	1.00	1.00	1.00

*Viewpoint I

DISCUSSION

- Only moderate reliability outcomes obtained
  - Partly due to minimal instructions to coders
  - Primarily due to complexity of problem
    - Not 1-to-1 correspondence between two coding systems
    - 389 possible PC codes versus about 10,000 ICD-9-CM diagnosis codes (or 1,000 3-character ICD9 codes)
- Mixed reliability for top PC codes in existing models

RECOMMENDATIONS

- Redo mapping effort
  - Provide better data collection directions
  - Convert from diagnosis codes to PC codes
  - Use Delphi method to improve consistency
- Look at a DRG-type mapping process
  - Decision tree to determine PC
- Replace PCs in models with another system that can be validated and periodically modified by real theater data

Questions?